Post-Closure Care Plan

POST-CLOSURE CARE PLAN

Chesapeake Energy Center Ash Landfill – Permit #440
And Bottom Ash Pond – VPDES Permit # VA0004081

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MAY 16 2016
Tidewater Regional Office

Dominion

Submitted To: Dominion – Chesapeake Energy Center
2701 Vepco Street
Chesapeake, Virginia 23323

Submitted By: Golder Associates Inc.
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Richmond, Virginia 23227

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Golder Associates

Table of Contents

Attachments

1.0 PURPOSE

This Post-Closure Care Plan (Plan) is for the Chesapeake Energy Center (CEC) Ash Landfill (landfill) at the CEC (Station), in Chesapeake, Virginia. For efficiency and to avoid confusion, this Plan also governs the post-closure care for the Bottom Ash Pond (pond) at CEC. The landfill is a captive industrial landfill, and at closure will contain approximately 976,000 cubic yards of Coal Combustion Residuals (CCR). Meanwhile, the pond, which served as a component of CEC's wastewater treatment system and is being closed at the same time as the landfill, will contain approximately 41,250 cubic yards of bottom ash at the time of closure,

The Plan includes post-closure requirements for the landfill pursuant to 9VAC20-81-170 of the Virginia Solid Waste Management Regulations (VSWMR) and for the pond pursuant to the authority of the VPDES permit and in accordance with 40 CFR 257.104 of the Disposal of Coal Combustion Residuals (CCR) from Electric Utilities rule and as adopted in VSWMR.

1.1 Post-Closure Period

The minimum required post-closure care period for the landfill and pond is 30 years.

1.2 Post-Closure Contact

The post-closure contact for this Station will be:

Dominion Generation Environmental Services
5000 Dominion Boulevard
Glen Allen, VA 23060
804-273-2929

2.0 INSPECTION, MONITORING, AND MAINTENANCE PLAN

2.1 Security Control Devices

The perimeter and access points of the landfill and pond will be inspected at least once per calendar month to verify the proper functioning of gates, fencing, and other perimeter security measures. Maintenance to the security devices shall be performed as soon as practicable. Areas and items to be inspected shall be those identified in Table 1 below.

Table 1
Post-Closure Inspection Schedule
CEC Ash Landfill and Bottom Ash Pond

Item	Inspection Items	Frequency of Inspection
Landfill Area	Gate and Fence	Monthly
	Erosion of closure cover	Monthly and after severe storms
	Settlement & Subsidence	Monthly
	Deterioration of vegetative cover	Monthly and after severe storms
	Trash, litter	Monthly
	Stormwater control system	Monthly and after severe storms
Bottom Ash Pond Area	Erosion of closure cover	Monthly and after severe storms
	Settlement & Subsidence	Monthly
	Deterioration of vegetative cover	Monthly and after severe storms
	Stormwater control system	Monthly and after severe storms
Landfill Leachate Collection System	Leachate flows, cleanouts and manholes	Monthly and after severe storms
Groundwater Monitoring System*	See Groundwater Monitoring Plan	See Groundwater Monitoring Plan

*The Groundwater Monitoring System for the landfill includes wells that are in proximity to the pond. Thus, the landfill monitoring system will also be used for post-closure care monitoring for the pond.

2.2 Final Cover Integrity

The final cover of the landfill and pond will be inspected at least once per calendar month and after severe storms to assess the condition of the cover and identify maintenance needs. Inspection items will include:

- Erosion damage to cover, stormwater channels, or stormwater basins;

- Settlement, subsidence, or displacement of the final cover;
- Evidence of animal intrusion or burrowing;
- Bare or dead vegetative cover;
- Woody vegetation growing on final cover areas; and,
- Evidence of seeps or saturated areas.

The landfill and pond areas shall be mowed at least two times per growing season to facilitate growth of grasses on the cover, enable inspection and preclude the establishment of woody vegetation. Application of fertilizer and/or reseeding shall take place as needed to maintain a healthy stand of vegetative cover.

2.3 Run-on and Run-off Controls

As part of the monthly and post-storm inspections, the stormwater run-off control system shall be inspected. Stormwater conveyances shall be observed for erosion damage, accumulated sediment, unusual settlement, and excessive or insufficient vegetative growth. Culverts shall be checked for blockage due to accumulated debris or sediment. Drop inlets shall be checked for debris accumulation.

Small amounts of sediment or debris shall be removed from areas if possible during the inspection, and the removal noted on the inspection record. Areas requiring repairs or more significant debris removal shall be repaired as soon as practicable and as necessary to ensure proper function of the system.

2.4 Landfill Leachate Collection System

During post-closure care, landfill leachate will be collected from the perimeter of the closed landfill and either pumped or feed by gravity to the landfill's Stormwater / Leachate Basin A. From Basin A, it will flow into and be comingled in Stormwater / Leachate Basin B with the Station's stormwater run-off and discharged through a permitted outfall (Outfall 002) into Deep Creek. Outfall 002 is a permitted outfall regulated under Virginia Pollutant Discharge Elimination system (VPDES) Permit # VA0004081.

The leachate collection system shall be inspected as part of the monthly site inspections and after severe storms to assess the condition of the system and identify maintenance needs. Items needing repair shall be repaired as soon as practicable and as necessary to ensure proper function of the system.

The perimeter of the landfill will be observed for the presence of wet or saturated areas that appear out of place during dry weather, as this may be indicative of a leachate seep or broken leachate force main. If a leachate seep or broken force main is identified, the Station shall be notified to repair the seep and complete the following actions:

- Take all immediate steps necessary to protect public health and safety including those required by the contingency plan (included in the landfill operations manual);
- Take immediate action to minimize, control, eliminate the seep or isolate the broken leachate force main, and contain and properly manage the leachate at the source; and,

- Where practicable, properly collect and dispose of the landfill leachate released outside the lined area.

Following the immediate response to the seep or broken force main, an evaluation shall be made to consider if further remedial action is required to prevent further seeps and/or collect and contain leachate before it can be released uncontrolled from the landfill.

2.5 Groundwater Monitoring System

Groundwater monitoring at the landfill shall continue as described in the *Groundwater Monitoring Plan*. Given the proximity of the groundwater monitoring wells to the pond, they will also be used to perform post-closure care monitoring for the bottom ash pond. Identified maintenance needs shall be repaired as soon as practicable.

2.6 Landfill Gas Monitoring System

No post-closure landfill gas monitoring is proposed for the landfill as it is a captive industrial monofill for CCR.

3.0 POST-CLOSURE USES

Post-closure use shall be in accordance with the provisions of the Virginia Solid Waste Management Regulations (VSWMR). Access to the site will be restricted. At the time of closure, Dominion may explore alternate safe uses for the landfill and pond under the regulations that will exist at that time. Post-closure activities will be designed and conducted so as to not disturb the integrity of the final cover systems, the components of any containment systems, or the function of the monitoring systems. Any post-closure uses not specifically addressed in this Closure Plan must have prior approval from the DEQ.

4.0 POST-CLOSURE COST ESTIMATE

The estimated cost for post-closure care of the landfill and pond is $2,414,000. Calculation of the post-closure care cost estimate is included in Attachment 2.

5.0 POST-CLOSURE CARE TERMINATION

At the end of the 30-year post-closure care period, Dominion may submit a request to terminate post-closure care in accordance with the CCR rule and VSWMR.

Closure Maintenance Checklist	
Inspector:	Date:
Task	**Remarks**
1.0 Cover Diversion Ditches • Clear of debris & sediment • Erosion • Drop inlets open and functioning	
2.0 Closure Cover • Perimeter ditches clear of debris & sediment • Erosion of closure cap • Litter • Vegetation condition • Indications of settlement	
3.0 Leachate Collection System • Leachate manhole condition • Pump operation • Piping damage or clogging • Cleanout damage and check for leaks • Collection manhole and valve – check for leaks, accumulated liquids	
4.0 Run-off Collection System • Downslope pipes clear of debris and accumulated sediment • Outlet protection free of accumulated sediment and large plant growth • Solids level in basin	
5.0 Facility Structures • Perimeter fence and gate condition • Access road condition • Monitoring well condition • Vegetation condition	

DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

Solid Waste Disposal Facility Cost Estimate Form

Facility Name:	CEC Ash Landfill			Permit No. SWP	440
Address:	2701 Vepco Street				
City:	Chesapeake	State:	VA	Zip:	23323
FA Holder:	Dominion Resources Services, Inc.				
Estimate Prepared By:	Golder Associates Inc.				

Indicate the plan versions for which this cost estimate was prepared, identifying the following information for each plan:

Closure Plan				**Post-Closure Care Plan**			
Title:	CEC Ash Landfill Closure Plan			Title:	CEC Ash Landfill and Bottom Ash Pond Post-Closure Care Plan		
Plan Date:	May 2014	Approved:		Plan Date:	May 2016	Approved:	
Consultant:	Golder Associates Inc.			Consultant:	Golder Associates Inc.		
Corrective Action Plan				**Corrective Action Monitoring Plan**			
Title:	n/a			Title:	n/a		
Plan Date:		Approved:		Plan Date:		Approved:	
Consultant:				Consultant:			

Cost Estimate Summary	
Total Closure Cost:	$5,107,893
Total Post-Closure Cost:	$2,413,485
Total Corrective Action Cost:	$974,000
TOTAL:	**$8,495,378**

References

Please indicate references used to develop this cost estimate: Closure Construction bids for Dominion's ash landfill 2008 closure construction in Clover, VA and other recent landfill construction projects in the consultant's area.

Certification by Preparer:

This is to certify that the cost estimates pertaining to the engineering features and monitoring requirements of this solid waste management facility have been prepared by me and are representative of the design specified in the facility's approved Closure, Post-Closure and Corrective Action Plans. The estimate is based on the cost of hiring a third party and does not incorporate any salvage value that may be realized by the sale of wastes, facility structures, or equipment, land or other facility assets at the time of partial or final closure. In my professional judgment, the cost estimates are a true, correct, and complete representation of the financial liabilities for closure, post-closure care, and corrective action of the facility and comply with the requirements of 9 VAC 20-70 and all other DEQ rules and statutes of the Commonwealth of Virginia.

Name:	Daniel McGrath, P.E.	Signature:	Daniel McGrath
Title:	Associate and Senior Consultant	Date:	5/10/16

Acknowledgement by Owner/Operator :

Name:	David A. Cooymer	Signature:	
Title:	VP, Power Generation System Operations	Date:	5/10/16

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Chesapeake Energy Center Ash Landfill and Bottom Ash Pond
Summary of Closure and Post-Closure Care Costs

Facility	Landfill	BA Pond	Total
Area, Acres	23	4.2	27.2
Closure Cost	$ 4,364,280	$ 743,613	$ 5,107,893
Post-Closure Care Cost	$ 2,170,003	$ 243,482	$ 2,413,485

Last Revised: May 2016

Worksheet CEW-01: FORMAT FOR THE ESTIMATION OF CLOSURE COSTS

FILL IN THE BOXES. THE REST WILL BE CALCULATED FOR YOU

Soil Cap Components

				Calculation or Conversion	
I.	**Slope & Fill**				
a.	Area to be capped	23	acres	x 4,840yd2/ac	111,320 yd2
b.	Depth of soil needed for slope and fill	6	inches	x 1yd/36in	0.17 yd
c.	Quantity of soil needed			a x b	18,553 yd3
d.	Percentage of soil from off-site	0%			
e.	Purchace unit cost for off-site material	$18.00	/yd3		
f.	Percentage of soil from on-site			(1 - d)	100%
g.	Excavation unit cost (on-site material)	$5.00	/yd3		0
h.	Total soil unit cost			(d x e) + (f x g)	$5.00 /yd3
i.	Hauling, Placement and Spreading unit cost	$3.00	/yd3		0
j.	Compaction unit cost	$0.62	/yd3		
k.	Total soil unit cost			h + i + j	$8.62 /yd3
l.	Soil subtotal			k x b	$159,930
m.	Percent compaction	10%			
	Total Slope & Fill Cost			l x (1 + m)	***$175,923***
II.	**Infiltration Layer Soil**				
	Infiltration Soil Cost				
a.	Area to be capped	23	acres	x 4,840yd2/ac	111,320 yd2
b.	Depth of infiltration soil needed	0	inches	x 1yd/36in	0.00 yd
c.	Quantity of infiltration soil needed			a x b	0 yd3
d.	Percentage of soil from off-site	100%			
e.	Purchace unit cost for off-site material	$18.00	/yd3		
f.	Percentage of soil from on-site			(1 - d)	0%
g.	Excavation unit cost (on-site material)	$0.00	/yd3		
h.	Total infiltration soil unit cost			(d x e) + (f x g)	$18.00 /yd3
i.	Hauling, Placement and Spredding unit cost	$3.00	/yd3		
j.	Compaction unit cost	$0.62	/yd3		
k.	Total infiltration soil unit cost			h + i + j	$21.62 /yd3
l.	Infiltration soil subtotal			k x b	$0
m.	Percent compaction	10%			
n.	*Subtotal Infiltration Soil Cost*			l x (1 + m)	*$0*
	Soil Admixture Cost				
o.	Area to be capped	0	acres	x 4,840yd2/ac	0 yd2
p.	Soil admixture unit cost	$2.85	/yd2		
q.	*Subtotal admixture cost*			a x b	*$0*
	Soil Testing				
r.	Area to be capped	28	acres		
s.	Testing unit cost	$0.00	/acre		
t.	*Subtotal soil testing cost*			a x b	*$0*
	Total Infiltration Soil Cost (soil, admixtures, and testing)			n + q + t	***$0***

III.	**Erosion Control / Protective Cover Soil**				
a.	Area to be capped	23	acres	x 4,840yd2/ac	111,320 yd2
b.	Depth of soil needed	18	inches	x 1yd/36in	0.50 yd
c.	Quantity of soil needed			a x b	55,660 yd3
d.	Percentage of soil from off-site	100%			
e.	Purchace unit cost for off-site material	$15.00	/yd3		
f.	Percentage of soil from on-site			(1 - d)	0%
g.	Excavation unit cost (on-site material)	$0.00	/yd3		
h.	Total erosion/protective soil unit cost			(d x e) + (f x g)	$15.00 /yd3
i.	Hauling, Placement and Spredding unit cost	$3.00	/yd3		
j.	Compaction unit cost	$0.62	/yd3		
k.	Total soil unit cost			h + i + j	$18.62 /yd3
l.	Erosion/Protective soil subtotal			k x b	$1,036,389
m.	Percent compaction	10%			
	Total Erosion Control/Protective Cover Soil Cost			l x (1 + m)	***$1,140,028***
IV.	**Vegetative support soil (Topsoil)**				
a.	Area to be capped	23	acres	x 4,840yd2/ac	111,320 yd2
b.	Depth of topsoil needed	6	inches	x 1yd/36in	0.17 yd
c.	Quantity of topsoil needed			a x b	18,553 yd3
d.	Percentage of topsoil from off-site	100%			
e.	Purchace unit cost for off-site material	$15.00	/yd3		
f.	Percentage of topsoil from on-site			(1 - d)	0%
g.	Excavation unit cost (on-site material)	$0.00	/yd3		
h.	Total topsoil unit cost			(d x e) + (f x g)	$15.00 /yd3
i.	Hauling, Placement and Spredding unit cost	$3.00	/yd3		
j.	Total soil unit cost			h + i	$18.00 /yd3
	Total Topsoil Cost			c x j	***$333,960***
V.	**Vegetative Cover**				
a.	Area to be vegetated	28	acres		
b.	Vegetative cover (seeding) unit cost	$3,100	/acre		
c.	Erosion control matting unit cost	$8,800	/acre		
	Total Vegetative Cover Cost			a x (b + c)	***$333,200.00***

Soil Cap Component Subtotal (I + II + III + IV + V): $1,983,111

Geosynthetic Barrier & Infiltration Layers

				Calculation or Conversion	
VI.	**Flexible Membrane Liner**				
a.	Quantity of FML needed	23	acres	x 43,560ft2/ac	1,001,880 ft2
b.	Purchase unit cost	$0.30	/ft2		
c.	Installation unit cost	$0.18	/ft2		
d.	Total FML unit cost			b + c	$0.48
	Total FML cost			a x d	***$480,902***
VII.	**Geosynthetic Clay Liner**				
a.	Quantity of GCL needed	0	acres	x 43,560ft2/ac	0 ft2
b.	Purchase unit cost	$0.00	/ft2		
c.	Installation unit cost	$0.00	/ft2		
d.	Total GCL unit cost			b + c	$0.00 /ft2
	Total GCL Cost			a x d	***$0***

Geosynthetic Layers Subtotal (VI + VII): $480,902

Drainage Components

				Calculation or Conversion	
VIII.	**Sand or Gravel Drainage**				
a.	Area to be capped	23	acres	x 4,840yd2/ac	111,320 yd2
b.	Depth of sand or gravel needed	0	inches	x 1yd/36in	0.00 yd
c.	Quantity of drainage material needed			a x b	0 yd3
d.	Percentage of media from off-site	100%			
e.	Purchace unit cost for off-site material	$16.49	/yd3		
f.	Percentage of material from on-site			(1 - d)	0%
g.	Excavation unit cost (on-site material)	$0.00	/yd3		
h.	Total drainage material unit cost			(d x e) + (f x g)	$16.49 /yd3
i.	Hauling, Placement and Spredding unit cost	$1.65	/yd3		
j.	Compaction unit cost	$0.82	/yd3		
k.	Total drainage material unit cost			h + i + j	$18.96 /yd3
l.	Drainage material subtotal			k x b	$0.00
m.	Percent compaction	10%			
	Total drainage material cost			l x (1 + m)	***$0***
IX.	**Geotextile**				
a.	Quantity of geotextile needed	1	acres	x 43,560ft2/ac	43,560 ft2
b.	Purchase unit cost	$0.11	/ft2		
c.	Installation unit cost	$0.05	/ft2		
d.	Total geotextile unit cost			b + c	$0.16 /ft2
	Total Geotextile Cost			a x d	***$7,081***
X.	**Geonet Composite**				
a.	Quantity of geonet composite needed	23	acres	x 43,560ft2/ac	1,001,880 ft2
b.	Purchase unit cost	$0.45	/ft2		
c.	Installation unit cost	$0.12	/ft2		
d.	Total geonet composite unit cost			b + c	$0.57 /ft2
	Total Geonet Composite Cost			a x d	***$571,072***
XI.	**Drainage Tile**				
a.	Length of drainage tile needed	3,800	LF		
b.	Purchase unit cost	$50.00	/LF		
c.	Trenching and backfilling cost	$65.00	/LF		
d.	Total drainage tile unit cost			b + c	$115.00 /ft2
	Total Drainage Tile Cost			a x d	***$437,000***

XII. Drainage Channels (Stormwater Control)

Drainage benches and berms

a.	Length of drainage bench needed	6,525	LF		
b.	Drainage bench unit cost	$5	/LF		
c.	*Subtotal drainage bench cost*			a x b	*$32,625*
d.	Length of 24" drainage pipe needed	730	LF		
e.	Drainage swale/berm unit cost	$55	/LF		
f.	*Subtotal drainage swale/berm cost*			d x e	*$40,150*

Rip Rap

g.	Quantity of Rip Rap needed	200	yd2		
h.	Rip rap unit cost	$35.00	/yd2		
i.	*Total rip rap cost*			g x h	*$7,000*

Gabian Baskets

j.	Quantity of gabian baskets needed	0	yd3		
k.	Gabian basket unit cost	$25.00	/yd3		
l.	Subtotal gabian basket cost			j x k	*$0*
	Total Stormwater Control			c + f + i + l	***$79,775***

Drainage Component Subtotal (VIII + IX + X + XI+ XII): $1,094,928

Landfill Gas and Groundwater Features

XIII. Landfill Gas Monitoring & Control Components — Calculation

Landfill Perimeter System

a.	Number of probes to be installed	0	probes		
b.	LFG probe unit cost	$1,099	/probe		
c.	*Subtotal LFG probe cost*			a x b	*$0*

Landfill Control Systems

d.	Area to be closed	28	acres		
e.	Average number of vents per acre	0	vents / acre		
f.	LFG vent unit cost	$3,518	/vent		
g.	*Subtotal LFG vent cost*			d x e x f	*$0*
h.	Length of header pipe needed		LF		
i.	Header pipe unit cost	$2.79	/LF		
j.	Header pipe installation cost	$5.59	/LF		
k.	*Subtotal LFG active vent hook-up*			h x (i + j)	*$0*
	Total Landfill Gas Management Cost			c + g + k	***$0***

XIV. Groundwater Monitoring Components

a.	Hydrogeologic study cost	$0			
b.	Number of wells to be installed	1	wells		
c.	GW Monitoring Well unit cost	$1,270	/well		
d.	Number of wells > 50 ft length	0	wells		
e.	Additional well length over 50 ft	0	LF/well		
f.	Unit cost for additional well length	$25	/LF		
	Total Groundwater Monitoring Well Cost			a + (b x c) + (d x e x f)	***$1,270*** (Extend wells CE

Landfill Gas & Groundwater Features Subtotal (XIII + XIV): $1,270

Miscellaneous

				Calculation	
XV.	**Removal and Disposal of Stockpiled Material**				
a.	Quantity of stockpiled materials	-	yd3		
b.	Loading and Hauling unit cost	$1.68	/yd3		
c.	Disposal unit cost	$25.40	/yd3		
d.	***Total Removal/Disposal Cost***			a x (b + c)	***$0***
XVI.	**Erosion/Sediment Control**				
a.	Quantity of silt fence needed	5,000	LF		
b.	Silt Fence unit cost	$3.56	/LF		
	Total Silt Fence Cost			a x b	***$17,780***
XVII.	**Landfill Access Road**				
a.	Size of LF access road	1,400	yd2		
b.	Depth of gravel needed	6	inches	x 1yd/36in	0.2 yd
c.	Depth of asphalt needed	0	inches	x 1yd/36in	0.0 yd
d.	Total material needed			a x (b + c)	233 yd3
e.	Road material unit cost	$28.96	/yd3		
f.	Placement/Spreading unit cost	$3.56	/yd3		
	Total access road cost			c x (d + e)	***$7,586***
XVIII.	**Site Security**				
Fencing					
a.	Length of fencing needed	-	ft		
b.	Fence unit cost	$15.24	/ft		
c.	*Subtotal fencing cost*			a x b	*$0*
Gate or Barrier					
d.	Number of gates required	1			
e.	Gate unit cost	$1,219.20	/gate		
f.	*Subtotal gate cost*			d x e	*$1,219*
Closed Sign					
g.	Number of signs required	2			
h.	Sign unit cost	$75.00	/sign		
i.	*Subtotal sign cost*			g x h	*$150*
	Total site security cost			c + f + i	***$1,369***
XIX.	**Mobilization / Demobilization**				
a.	Cost for mobilization/demobilization	$45,000			
	Total mobilization/demobilization cost				***$45,000***
				Miscellaneous Subtotal (XV + ... + XIX):	**$71,735**

Closure Cost Subtotal (CCS):		(I + ... + XIX)	$3,631,946
City Cost Index (Small City)	100%=1		1
Adjusted Closure Cost (ACC)			$3,631,946
Contingency (10%):		CCS x 0.10	$363,195
Adjusted Closure Cost + Contingency (ACC+C)			$3,995,141
Engineering & Documentation:			
Construction QA/QC		$12,500 / Acre	$287,500
Closure Certification and CQA Report (1%)		ACC x 0.01	$36,319
Survey and as-builts (2%)		ACC x 0.01	$36,319
Cost for survey and deed notation			$9,000
Total Engineering & Documentation Costs			***$369,139***
Total Closure Cost:	ACC + Contingency + Engineering		**$4,364,280**

Worksheet CEW-02: FORMAT FOR THE ESTIMATION OF POST-CLOSURE COSTS

FILL IN THE BOXES. THE REST WILL BE CALCULATED FOR YOU

			Calculation or Conversion	
I. Groundwater Monitoring				
a. Total number of monitoring wells	12	wells		
b. Total number of sampling events/year	2	events/yr	a x b	24 samples/yr
c. Quantity of additional samples (e.g. QA/QC)	1	samples/even	a x c	12 samples/yr
d. Total samples per year			b + c	36 samples/yr
e. Analysis unit cost (Table 3.1 constituents)	$210.00	/sample	base price, ENCO Cost Sheet, VELAP Accredited	
f. *Total Analysis cost*			d x e	*$7,560.00* /yr
g. GW Monitoring unit cost	$3,048.00	/event		
i. *Total sampling cost*			f + (g x b)	*$13,656.00* /yr
j. Engineering fees & reports	$10,994	/yr		
Yearly Groundwater Monitoring Cost			i + j	***$24,650 /yr***
II. Landfill Gas Monitoring, Maintenance, and Control				
a. Frequency of LFG compliance monitoring	0	events/yr		
b. LFG Monitoring unit cost	$549.73	/event		
c. *Total perimeter LFG monitoring cost*			a x b	*$0* /yr
d. Frequency of suface monitoring (air permit)	0	events/yr		
e. Surface monitoring unit cost	$0.00	/event		
f. *Total surface monitoring cost*			d x e	*$0* /yr
g. Control system operating unit cost	$0	/yr		
h. Frequency of LFG control system inspections	0	events/yr		
i. Control system inspection cost	$0.00	/event		
j. *Total constrol system cost*			g + (h x i)	*$0* /yr
Yearly Landfill Gas Monitoring, Maintenance, & Control Cost			c + f + j	***$0 /yr***
III. Leachate Management				
a. Quantity of leachate generated	147,500	gal/yr		
On-site Leachate Management or Pre-Treatment				
b. On-site treatment operating unit cost	$0.00	/gal		
c. *Total on-site management cost*			a x b	*$0* /yr
Leachate Disposal				
d. Private disposal unit cost	$0.02	/gal		
e. POTW disposal unit cost	$0.0049	/gal		
f. Direct discharge to POTW unit cost	$0.0049	/gal		
g. Pump & Haul unit cost	$0.08	/gal		
h. Subtotal leachate disposal unit cost			d + e + f + g	$0.00
i. *Total leachate disposal cost*			a x h	*$0* /yr
j. Leachate sampling & analysis unit cost	$2,500.00	/sample		
k. Frequency of leachate sampling & analysis	1	sample/yr		
l. *Total leachate sampling & analysis cost*			j x k	*$2,500.00* /yr
Yearly Leachate Management Cost			c + i + l	***$2,500 /yr***

IV. Cap Maintenance & Repair

a. Closed Landfill Area	23	acres		
Mowing & Fertilization				
b. Mowing frequency	3	visits/yr		
c. Mowing unit cost	$65.00	/acre/visit		
d. *Total mowing cost*			a x b x c	*$4,485 /yr*
e. Fertilizer frequency	1	visits/yr		
f. Fertilizer unit cost	$305.52	/acre/visit		
g. *Total fertilizer cost*			a x e x f	*$7,027 /yr*
Cap Erosion & Repair				
h. Area to reseed/year			33% x a	7.7 acres
i. Reseeding unit cost	$2,500.00	/acre		
j. *Total reseeding cost*			h x i	*$19,166.67 /yr*
k. Area of cap erosion/year			10% x a	2.3 acres
l. Cap erosion repair unit cost	$2,500.00	/acre		
m. Mobilization/Demobilization	$250.00	/yr		
n. *Total cap erosion repair cost*			(k x l) + m	*$6,000 /yr*
Yearly Cap Maintenance & Repair cost			d + g + j + n	***$36,679 /yr***

V. Sediment Basin Maintenance & Repair

a. Sediment basin cleanout frequency, 1 per	3	years	1 / a	0.33 event/yr
b. Sediment basin cleanout unit cost	$10,000	/event		
c. Mobilization/Demobilization	$500	/event		
d. *Total sediment basin maintenance cost*			a x (b + c)	*$3,500 /yr*
e. Total number of stormwater sampling locations	1	locations		
f. Stormwater sampling frequency	1	events/yr		
g. Total number of stormwater samples			e x f	1 samples/yr
h. Analysis unit cost (VPDES permit parameters)	$250	/sample		
i. *Total Analysis cost*			g x h	*$250 /yr*
j. Mobilization unit cost	$152.40	/event		
k. Technician field unit cost	$152.40	/event		
l. *Total sampling cost*			f x (j + k)	*$304.80 /yr*
m. Engineering fees & reports	$500	/yr		
n. *Total Stormwater Sampling & Analysis cost*			i + l + m	*$1,055 /yr*
Yearly Sediment Basin Maintenance & Repair			d + n	***$4,555 /yr***

VI. Vector & Rodent Control

a. Vector and rodent control unit cost	$2,000	/yr		
Yearly Vector and Rodent Control Cost			a	***$2,000 /yr***

VII. Post-Closure Care General Inspections

a. General inspection unit cost	$500	/inspection		
b. Number of inspections per year	1			
Yearly Post-Closure Care General Inspection Cost			a x b	***$500 /yr***

CEC Ash Landfill, Permit No. 440
Chesapeake, VA

Annual Post-Closure Care Cost (APCC)		I + ... + VII	$70,884 /yr
Length of post-closure care (LPCC)	30 years		
Post-Closure Care Cost		APCC x LPCC	$2,126,517
City Cost Index (Small City)	100%=1		1
Adjusted Post-Closure Care Cost (AdjPCC)			$2,126,516.96
Engineering & Documentation		Engineering Sum	$22,221
Post-Closure Care Evaluation	$14,177	10% of Adj APCC	
Post-Closure Care Certification	$3,544	2% of Adj APCC	
Cost for survey and deed notation (if not completed at time of landfill closure)	$4,500	$500 per acre (9 acres)	
FA Mechanism Maintenance Cost	$709 /yr	FA maintenance x LPCC	$21,265
Total Post-Closure Care Cost		Post-Closure Cost + Engineering + FA Maintenance	**$2,170,003**

CEC Bottom Ash Pond
VPDES Permit #VA0004081
Chesapeake, VA
Worksheet CEW-01: FORMAT FOR THE ESTIMATION OF CLOSURE COSTS

FILL IN THE BOXES. THE REST WILL BE CALCULATED FOR YOU

Soil Cap Components

				Calculation or Conversion	
I.	**Slope & Fill**				
a.	Area to be capped	4.2	acres	x 4,840yd2/ac	20,328 yd2
b.	Depth of soil needed for slope and fill	6	inches	x 1yd/36in	0.17 yd
c.	Quantity of soil needed			a x b	3,388 yd3
d.	Percentage of soil from off-site	0%			
e.	Purchace unit cost for off-site material	$18.00	/yd3		
f.	Percentage of soil from on-site			(1 - d)	100%
g.	Excavation unit cost (on-site material)	$5.00	/yd3		0
h.	Total soil unit cost			(d x e) + (f x g)	$5.00 /yd3
i.	Hauling, Placement and Spreading unit cost	$3.00	/yd3		0
j.	Compaction unit cost	$0.62	/yd3		
k.	Total soil unit cost			h + i + j	$8.62 /yd3
l.	Soil subtotal			k x b	$29,205
m.	Percent compaction	10%			
	Total Slope & Fill Cost			l x (1 + m)	***$32,125***
II.	**Infiltration Layer Soil**				
Infiltration Soil Cost					
a.	Area to be capped	4.2	acres	x 4,840yd2/ac	20,328 yd2
b.	Depth of infiltration soil needed	0	inches	x 1yd/36in	0.00 yd
c.	Quantity of infiltration soil needed			a x b	0 yd3
d.	Percentage of soil from off-site	100%			
e.	Purchace unit cost for off-site material	$18.00	/yd3		
f.	Percentage of soil from on-site			(1 - d)	0%
g.	Excavation unit cost (on-site material)	$0.00	/yd3		
h.	Total infiltration soil unit cost			(d x e) + (f x g)	$18.00 /yd3
i.	Hauling, Placement and Spredding unit cost	$3.00	/yd3		
j.	Compaction unit cost	$0.62	/yd3		
k.	Total infiltration soil unit cost			h + i + j	$21.62 /yd3
l.	Infiltration soil subtotal			k x b	$0
m.	Percent compaction	10%			
n.	*Subtotal Infiltration Soil Cost*			l x (1 + m)	*$0*
Soil Admixture Cost					
o.	Area to be capped	0	acres	x 4,840yd2/ac	0 yd2
p.	Soil admixture unit cost	$2.85	/yd2		
q.	*Subtotal admixture cost*			a x b	*$0*
Soil Testing					
r.	Area to be capped	28	acres		
s.	Testing unit cost	$0.00	/acre		
t.	*Subtotal soil testing cost*			a x b	*$0*
	Total Infiltration Soil Cost (soil, admixtures, and testing)			n + q + t	***$0***

III.	**Erosion Control / Protective Cover Soil**				
a.	Area to be capped	4.2	acres	x 4,840yd2/ac	20,328 yd2
b.	Depth of soil needed	18	inches	x 1yd/36in	0.50 yd
c.	Quantity of soil needed			a x b	10,164 yd3
d.	Percentage of soil from off-site	100%			
e.	Purchace unit cost for off-site material	$15.00	/yd3		
f.	Percentage of soil from on-site			(1 - d)	0%
g.	Excavation unit cost (on-site material)	$0.00	/yd3		
h.	Total erosion/protective soil unit cost			(d x e) + (f x g)	$15.00 /yd3
i.	Hauling, Placement and Spredding unit cost	$3.00	/yd3		
j.	Compaction unit cost	$0.62	/yd3		
k.	Total soil unit cost			h + i + j	$18.62 /yd3
l.	Erosion/Protective soil subtotal			k x b	$189,254
m.	Percent compaction	10%			
	Total Erosion Control/Protective Cover Soil Cost			l x (1 + m)	***$208,179***
IV.	**Vegetative support soil (Topsoil)**				
a.	Area to be capped	4.2	acres	x 4,840yd2/ac	20,328 yd2
b.	Depth of topsoil needed	6	inches	x 1yd/36in	0.17 yd
c.	Quantity of topsoil needed			a x b	3,388 yd3
d.	Percentage of topsoil from off-site	100%			
e.	Purchace unit cost for off-site material	$15.00	/yd3		
f.	Percentage of topsoil from on-site			(1 - d)	0%
g.	Excavation unit cost (on-site material)	$0.00	/yd3		
h.	Total topsoil unit cost			(d x e) + (f x g)	$15.00 /yd3
i.	Hauling, Placement and Spredding unit cost	$3.00	/yd3		
j.	Total soil unit cost			h + i	$18.00 /yd3
	Total Topsoil Cost			c x j	***$60,984***
V.	**Vegetative Cover**				
a.	Area to be vegetated	4.2	acres		
b.	Vegetative cover (seeding) unit cost	$3,100	/acre		
c.	Erosion control matting unit cost	$8,800	/acre		
	Total Vegetative Cover Cost			a x (b + c)	***$49,980.00***

Soil Cap Component Subtotal (I + II + III + IV + V): $351,268

Geosynthetic Barrier & Infiltration Layers

				Calculation or Conversion	
VI.	**Flexible Membrane Liner**				
a.	Quantity of FML needed	4.2	acres	x 43,560ft2/ac	182,952 ft2
b.	Purchase unit cost	$0.30	/ft2		
c.	Installation unit cost	$0.18	/ft2		
d.	Total FML unit cost			b + c	$0.48
	Total FML cost			a x d	***$87,817***
VII.	**Geosynthetic Clay Liner**				
a.	Quantity of GCL needed	0	acres	x 43,560ft2/ac	0 ft2
b.	Purchase unit cost	$0.00	/ft2		
c.	Installation unit cost	$0.00	/ft2		
d.	Total GCL unit cost			b + c	$0.00 /ft2
	Total GCL Cost			a x d	***$0***

Geosynthetic Layers Subtotal (VI + VII): $87,817

Drainage Components

				Calculation or Conversion	
VIII.	**Sand or Gravel Drainage**				
a.	Area to be capped	4.2	acres	x 4,840yd2/ac	20,328 yd2
b.	Depth of sand or gravel needed	0	inches	x 1yd/36in	0.00 yd
c.	Quantity of drainage material needed			a x b	0 yd3
d.	Percentage of media from off-site	100%			
e.	Purchace unit cost for off-site material	$16.49	/yd3		
f.	Percentage of material from on-site			(1 - d)	0%
g.	Excavation unit cost (on-site material)	$0.00	/yd3		
h.	Total drainage material unit cost			(d x e) + (f x g)	$16.49 /yd3
i.	Hauling, Placement and Spredding unit cost	$1.65	/yd3		
j.	Compaction unit cost	$0.82	/yd3		
k.	Total drainage material unit cost			h + i + j	$18.96 /yd3
l.	Drainage material subtotal			k x b	$0.00
m.	Percent compaction	10%			
	Total drainage material cost			l x (1 + m)	***$0***
IX.	**Geotextile**				
a.	Quantity of geotextile needed	1	acres	x 43,560ft2/ac	43,560 ft2
b.	Purchase unit cost	$0.11	/ft2		
c.	Installation unit cost	$0.05	/ft2		
d.	Total geotextile unit cost			b + c	$0.16 /ft2
	Total Geotextile Cost			a x d	***$7,081***
X.	**Geonet Composite**				
a.	Quantity of geonet composite needed	4.2	acres	x 43,560ft2/ac	182,952 ft2
b.	Purchase unit cost	$0.45	/ft2		
c.	Installation unit cost	$0.12	/ft2		
d.	Total geonet composite unit cost			b + c	$0.57 /ft2
	Total Geonet Composite Cost			a x d	***$104,283***
XI.	**Drainage Tile**				
a.	Length of drainage tile needed	100	LF		
b.	Purchase unit cost	$50.00	/LF		
c.	Trenching and backfilling cost	$65.00	/LF		
d.	Total drainage tile unit cost			b + c	$115.00 /ft2
	Total Drainage Tile Cost			a x d	***$11,500***

XII. Drainage Channels (Stormwater Control)

Drainage benches and berms

a.	Length of drainage bench needed	622	LF		
b.	Drainage bench unit cost	$25	/LF		
c.	*Subtotal drainage bench cost*			a x b	*$15,550*
d.	Length of 24" drainage pipe needed	0	LF		
e.	Drainage swale/berm unit cost	$55	/LF		
f.	*Subtotal drainage swale/berm cost*			d x e	*$0*

Rip Rap

g.	Quantity of Rip Rap needed	200	yd2		
h.	Rip rap unit cost	$35.00	/yd2		
i.	*Total rip rap cost*			g x h	*$7,000*

Gabian Baskets

j.	Quantity of gabian baskets needed	0	yd3		
k.	Gabian basket unit cost	$25.00	/yd3		
l.	Subtotal gabian basket cost			j x k	*$0*
	Total Stormwater Control			c + f + l + l	***$22,550***

Drainage Component Subtotal (VIII + IX + X + XI+ XII): $145,414

Landfill Gas and Groundwater Features

XIII. Landfill Gas Monitoring & Control Components

				Calculation	
Landfill Perimeter System					
a.	Number of probes to be installed	0	probes		
b.	LFG probe unit cost	$1,099	/probe		
c.	*Subtotal LFG probe cost*			a x b	*$0*
Landfill Control Systems					
d.	Area to be closed	4.2	acres		
e.	Average number of vents per acre	0	vents / acre		
f.	LFG vent unit cost	$3,518	/vent		
g.	*Subtotal LFG vent cost*			d x e x f	*$0*
h.	Length of header pipe needed	-	LF		
i.	Header pipe unit cost	$2.79	/LF		
j.	Header pipe installation cost	$5.59	/LF		
k.	*Subtotal LFG active vent hook-up*			h x (i + j)	*$0*
	Total Landfill Gas Management Cost			c + g + k	***$0***

XIV. Groundwater Monitoring Components

a.	Hydrogeologic study cost	$0		
b.	Number of wells to be installed	0	wells	
c.	GW Monitoring Well unit cost	$1,270	/well	
d.	Number of wells > 50 ft length	0	wells	
e.	Additional well length over 50 ft	0	LF/well	
f.	Unit cost for additional well length	$25	/LF	
	Total Groundwater Monitoring Well Cost			a + (b x c) + (d x e x f) ***$0***

Landfill Gas & Groundwater Features Subtotal (XIII + XIV): $0

Miscellaneous

XV.	**Removal and Disposal of Stockpiled Material**			Calculation	
a.	Quantity of stockpiled materials	-	yd3		
b.	Loading and Hauling unit cost	$1.68	/yd3		
c.	Disposal unit cost	$25.40	/yd3		
d.	***Total Removal/Disposal Cost***			a x (b + c)	***$0***
XVI.	**Erosion/Sediment Control**				
a.	Quantity of silt fence needed	1,500	LF		
b.	Silt Fence unit cost	$3.56	/LF		
	Total Silt Fence Cost			a x b	***$5,334***
XVII.	**Landfill Access Road**				
a.	Size of LF access road	-	yd2		
b.	Depth of gravel needed	6	inches	x 1yd/36in	0.2 yd
c.	Depth of asphalt needed	0	inches	x 1yd/36in	0.0 yd
d.	Total material needed			a x (b + c)	0 yd3
e.	Road material unit cost	$28.96	/yd3		
f.	Placement/Spreading unit cost	$3.56	/yd3		
	Total access road cost			c x (d + e)	***$0***
XVIII.	**Site Security**				
Fencing					
a.	Length of fencing needed	-	ft		
b.	Fence unit cost	$15.24	/ft		
c.	*Subtotal fencing cost*			a x b	*$0*
Gate or Barrier					
d.	Number of gates required	-			
e.	Gate unit cost	$1,219.20	/gate		
f.	*Subtotal gate cost*			d x e	*$0*
Closed Sign					
g.	Number of signs required	-			
h.	Sign unit cost	$75.00	/sign		
i.	*Subtotal sign cost*			g x h	*$0*
	Total site security cost			c + f + i	***$0***
XIX.	**Mobilization / Demobilization**				
a.	Cost for mobilization/demobilization	$25,000			
	Total mobilization/demobilization cost				***$25,000***
				Miscellaneous Subtotal (XV + ... + XIX):	**$30,334**

CEC Bottom Ash Pond
VPDES Permit #VA0004081
Chesapeake, VA

Closure Cost Subtotal (CCS):		(I + ... + XIX)	$614,833
City Cost Index (Small City)	100%=1		1
Adjusted Closure Cost (ACC)			$614,833
Contingency (10%):		CCS x 0.10	$61,483
Adjusted Closure Cost + Contingency (ACC+C)			$676,316
Engineering & Documentation:			
Construction QA/QC		$12,500 / Acre	$52,500
Closure Certification and CQA Report (1%)		ACC x 0.01	$6,148
Survey and as-builts (2%)		ACC x 0.01	$6,148
Cost for survey and deed notation			$2,500
Total Engineering & Documentation Costs			***$67,297***
Total Closure Cost:	ACC + Contingency + Engineering		**$743,613**

CEC Bottom Ash Pond
VPDES Permit #VA0004081
Chesapeake, VA

Worksheet CEW-02: FORMAT FOR THE ESTIMATION OF POST-CLOSURE COSTS

FILL IN THE BOXES. THE REST WILL BE CALCULATED FOR YOU

			Calculation or Conversion	
I. Groundwater Monitoring				
a. Total number of monitoring wells	0	wells		
b. Total number of sampling events/year	0	events/yr	a x b	0 samples/yr
c. Quantity of additional samples (e.g. QA/QC)	1	samples/even	a x c	0 samples/yr
d. Total samples per year			b + c	0 samples/yr
e. Analysis unit cost (Table 3.1 constituents)	$210.00	/sample	base price, ENCO Cost Sheet, VELAP Accredited	
f. *Total Analysis cost*			d x e	*$0.00 /yr*
g. GW Monitoring unit cost	$3,048.00	/event		
i. *Total sampling cost*			f + (g x b)	*$0.00 /yr*
j. Engineering fees & reports	$0	/yr		
Yearly Groundwater Monitoring Cost			i + j	***$0 /yr***
II. Landfill Gas Monitoring, Maintenance, and Control				
a. Frequency of LFG compliance monitoring	0	events/yr		
b. LFG Monitoring unit cost	$549.73	/event		
c. *Total perimeter LFG monitoring cost*			a x b	*$0 /yr*
d. Frequency of suface monitoring (air permit)	0	events/yr		
e. Surface monitoring unit cost	$0.00	/event		
f. *Total surface monitoring cost*			d x e	*$0 /yr*
g. Control system operating unit cost	$0	/yr		
h. Frequency of LFG control system inspections	0	events/yr		
i. Control system inspection cost	$0.00	/event		
j. *Total constrol system cost*			g + (h x i)	*$0 /yr*
Yearly Landfill Gas Monitoring, Maintenance, & Control Cost			c + f + j	***$0 /yr***
III. Leachate Management				
a. Quantity of leachate generated		gal/yr		
On-site Leachate Management or Pre-Treatment				
b. On-site treatment operating unit cost	$0.00	/gal		
c. *Total on-site management cost*			a x b	*$0 /yr*
Leachate Disposal				
d. Private disposal unit cost	$0.02	/gal		
e. POTW disposal unit cost	$0.0049	/gal		
f. Direct discharge to POTW unit cost	$0.0049	/gal		
g. Pump & Haul unit cost	$0.08	/gal		
h. Subtotal leachate disposal unit cost			d + e + f + g	$0.00
l. *Total leachate disposal cost*			a x h	*$0 /yr*
j. Leachate sampling & analysis unit cost	$2,500.00	/sample		
k. Frequency of leachate sampling & analysis	0	sample/yr		
l. *Total leachate sampling & analysis cost*			j x k	*$0.00 /yr*
Yearly Leachate Management Cost			c + i + l	***$0 /yr***

IV. Cap Maintenance & Repair

a. Closed Landfill Area	4.2	acres		
Mowing & Fertilization				
b. Mowing frequency	3	visits/yr		
c. Mowing unit cost	$65.00	/acre/visit		
d. *Total mowing cost*			a x b x c	*$819* /yr
e. Fertilizer frequency	1	visits/yr		
f. Fertilizer unit cost	$300.00	/acre/visit		
g. *Total fertilizer cost*			a x e x f	*$1,260* /yr
Cap Erosion & Repair				
h. Area to reseed/year			33% x a	1.4 acres
i. Reseeding unit cost	$2,500.00	/acre		
j. *Total reseeding cost*			h x i	*$3,500.00* /yr
k. Area of cap erosion/year			10% x a	0.4 acres
l. Cap erosion repair unit cost	$2,500.00	/acre		
m. Mobilization/Demobilization	$0.00	/yr		
n. *Total cap erosion repair cost*			(k x l) + m	*$1,050* /yr
Yearly Cap Maintenance & Repair cost			d + g + j + n	***$6,629 /yr***

V. Sediment Basin Maintenance & Repair

a. Sediment basin cleanout frequency, 1 per	12	years	1 / a	0.08 event/yr
b. Sediment basin cleanout unit cost	$10,000	/event		
c. Mobilization/Demobilization	$500	/event		
d. *Total sediment basin maintenance cost*			a x (b + c)	*$875* /yr
e. Total number of stormwater sampling locations	1	locations		
f. Stormwater sampling frequency	0	events/yr		
g. Total number of stormwater samples			e x f	0 samples/yr
h. Analysis unit cost (VPDES permit parameters)	$250	/sample		
i. *Total Analysis cost*			g x h	*$0* /yr
j. Mobilization unit cost	$152.40	/event		
k. Technician field unit cost	$152.40	/event		
l. *Total sampling cost*			f x (j + k)	*$0.00* /yr
m. Engineering fees & reports	$0	/yr		
n. *Total Stormwater Sampling & Analysis cost*			i + l + m	*$0* /yr
Yearly Sediment Basin Maintenance & Repair			d + n	***$875 /yr***

VI. Vector & Rodent Control

a. Vector and rodent control unit cost	$0	/yr		
Yearly Vector and Rodent Control Cost			a	***$0 /yr***

VII. Post-Closure Care General Inspections

a. General inspection unit cost	$500	/inspection		
b. Number of inspections per year	1			
Yearly Post-Closure Care General Inspection Cost			a x b	***$500 /yr***

CEC Bottom Ash Pond
VPDES Permit #VA0004081
Chesapeake, VA

Annual Post-Closure Care Cost (APCC)		I + ... + VII	$8,004 /yr
Length of post-closure care (LPCC)	30 years		
Post-Closure Care Cost		APCC x LPCC	$240,120
City Cost Index (Small City)	100%=1		1
Adjusted Post-Closure Care Cost (AdjPCC)			$240,120.00
Engineering & Documentation		Engineering Sum	$960
Post-Closure Care Evaluation	$800	10% of Adj APCC	
Post-Closure Care Certification	$160	2% of Adj APCC	
Cost for survey and deed notation (completed at time of landfill closure)	$0	$500 per acre (4.2 acres)	
FA Mechanism Maintenance Cost	$80 /yr	FA maintenance x LPCC	$2,401
Total Post-Closure Care Cost		Post-Closure Cost + Engineering + FA Maintenance	**$243,482**

Established in 1960, Golder Associates is a global, employee-owned organization that helps clients find sustainable solutions to the challenges of finite resources, energy and water supply and management, waste management, urbanization, and climate change. We provide a wide range of independent consulting, design, and construction services in our specialist areas of earth, environment, and energy. By building strong relationships and meeting the needs of clients, our people have created one of the most trusted professional services organizations in the world.

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Golder Associates

Engineering Earth's Development, Preserving Earth's Integrity

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